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ORIGINAL ARTICLE

Prevalence of premastication among children aged 6–36 months and its association with health: A cross-sectional study in eight cities of China

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Abstract

Premastication is thought to be an adaptive behavior in the introduction of complementary plant-bassed food to infants. It arouses controversy, however, because of the potential for transmitting saliva-born infectious diseases. The aim of this study was to explore whether premastication by healthy caregivers was associated with children's health and behavior. The data were collected as part of the Maternal and Infant Nutrition and Growth study. From 8 cities in China, 1341 pairs of infants/toddlers and their caregivers were recruited. An interviewer-administrated questionnaire collected data on sociodemographic characteristics, feeding behaviors, and self-reported health status. Anthropometric measurements were taken and blood samples were collected for analysis of hemoglobin levels. The overall prevalence of premastication was 26.9% and varies from 14–43% among the 8 cities. Premastication was not associated with occurrences of illness or with the nutritional indicators of height-for-age Z score, weight-for-age Z score, weight-for-height Z score, head circumference Z score and hemoglobin (P all >.05). Premastication occurred more often among infants who were raised by their parents (P = .005), whose mothers' education was lower (P < .001), who were subject to more concern from their parents (P = .022), and whose parents thought their children had an obesity problem (P = .001). Presmastication was not associated with food picky behaviors. Premastication is still a common feeding practice in China. More studies are needed to determine the biological, economic, and cultural benefits or harm from premastication.

KEYWORDS

child public health, complementary feeding, early growth, food security, infant feeding behaviour, parenting

1 | INTRODUCTION

Premastication or prechewing—that is, chewing foods or medicines before feeding to a child (Center For Disease Control, 2011)—has been a common practice in human society. Although it is described sporadically in various parts of the world, the rates vary dramatically (Gaur et al., 2009: Habicht & Pelto, 2016; Lewis, Riedy, Grossman, Domoto, & Roberts, 2002; Ogunshe, Lahan, David, & Verissimo, 2013). It is seems likely that premastication is no longer widely practiced in developed countries. However, some studies have shown that premastication was not rare in the United States, especially in Black mothers (Bulkow, Singleton, Karron, & Harrison, 2002). In some areas of developing countries, premastication rates are over 50% (Auer-Hackenberg et al., 2014). Data on premastication in Asian countries are scant. A review of the Chinese and international scientific literature revealed a dearth of information about the prevalence of premastication in China. Although Pelto, Zhang, and Habicht (2010) estimated that 63% of university students had been premasticated as babies, this is not a prevalence estimate because it lacks a population-based denominator (Pelto et al., 2010). There was no further prevalence information obtained through searches in the two major e-journal databases in China: CNKI and WANG FANG databases. Similarly, searches in Pubmed, Science Online, and Google Scholar did not yield information.

As a recommended source of infant nutrition, prechewed food was documented in Persia as early as 1025 AD (Conkle, Ramakrishnan, & Freeman, 2016). Premastication was thought to be a crucial behavioral adaptation throughout the course of human evolution to ensure that infants received adequate nutrition during the complementary feeding period (Pelto et al., 2010). As a necessary adaption before teeth eruption, two studies from the mid-20th century lend some support to the role of premastication in the prevention of malnutrition (Fry, 1957; Pijoan & Elkia, 1943). There is, however, no scientific evidence to support nutritional benefits from premastication when substitutes based on modern food technology are available (Pelto et al., 2010). In addition, one study reported that premastication was associated with an increased risk of diarrhea in infants (Conkle et al., 2016). Other studies have suggested that premastication may expose the child to blood from the mouth of an adult, increasing the risk of transmission of human immunodeficiency virus (HIV), human herpesvirus-8, and other saliva- or blood-borne viruses (Butler, Neilands, Mosam, Mzolo, & Martin, 2010; Crabtree et al., 2014; Gaur et al., 2009; Pattanaporn et al., 2013). These reports have recently caused public concern, and they have driven premastication to be seen as a negative behavior (Habicht & Pelto, 2016). On the other hand, abundant antimicrobials have been reported in maternal saliva, which might helpful to prevent infants from infectious diseases (Pelto et al., 2010). Mothers also transfer oral microflora to infants, which might provide potential benefits (Aaltonen & Tenovuo, 1994). An observational study has shown that premastication was a protective factor of hospitalization for acute respiratory infection among Alaska-Native infants who were younger than 6 months (Bulkow et al., 2002). Therefore, the role of presmastication in the infants' nutritional status and health is still unknown. At present, premastication is neither recommended nor discouraged by the World Health Organization.

In 2015, China published updated feeding guidelines for infants and toddlers in which premastication was not included (Chinese Society of Nutrition, 2016). Although the mortality rate among children under 5 years in China declined from 44.5% to 11.7% between 1995 and 2013, malnutrition continues to exist (National Bureau of Statistics of China, 2016). In 2013, the overall prevalence of stunting, underweight, and wasting of Chinese children under 5 years were 8.1%, 2.4%, and 1.9%, respectively (Yu et al., 2016). It is, therefore, worthwhile investigating whether premastication has benefits for Chinese children. Furthermore, because most premastication studies have focused on mothers with infectious diseases, it is important to explore the effects of premastication by generally healthy caregivers. The aims of this study are (a) to provide premastication prevalence estimates for defined urban populations of children born in hospitals and (b) to examine whether premastication by healthy caregivers is associated with the child's nutritional status, health, and behaviors.

Key messages

- Premastication is still a common feeding practice in the eight studied Chinese cities, and varies from 14% to 43% among the cities.
- There was no evidence for harmful or beneficial effects on the growth or health of children who were fed with premasticated food.
- Premastication was more likely to occur in infants who were raised by their parents, whose mothers had lower levels of education, and who were most concerned about their children's weight and health.
- Further research is needed to determine the biological, economic, and cultural benefits or harm from premastication, with particular emphasis on children with poor complementary food supplies and for whom their parents have health concerns.

2 | PARTICIPANTS AND METHOD

2.1 | Participants

This study is part of the Maternal and Infant Nutrition and Growth (MING) study, and the research design and subject recruitment have been described in detail elsewhere (see Chen et al., 2015). The MING study was a cross-sectional study of the dietary and nutritional status and health of pregnant women, lactating mothers, infants, and toddlers. Briefly, eight Chinese cities (i.e., Beijing, Suzhou, Guangzhou, Shanghai, Shenyang, Zhengzhou, Chengdu, and Lanzhou) were selected. In each city, two maternal and children's hospitals were randomly selected by computer. Based on the register information in the hospitals, infants and toddlers aged 6–36 months and their primary caregivers were approached for recruitment. The inclusion criteria were single birth, mothers aged from 21 to 45 years old, and who had lived in the investigated city over 1 year. The infants, their mothers, and caregivers with physical disability, with AIDS or HIV infection, hepatitis B and other diagnosed infectious diseases, and with diabetes, hypertension, or other serious disease based on the self-report and medical records in the hospital were all excluded (gestational diabetes and hypertension were not excluded). Finally, 1,376 subjects voluntarily participated in the MING study (the response rate was 66%). According to the purpose of this study, 21 of the subjects were excluded because of missing values or uncertain responses in the key questions (birth date, gender, and whether premastication or not) and 14 were excluded because they had not as yet introduced any complementary food.

2.2 | Data collection

An interviewer-administrated questionnaire was used to collect data from the children's primary caregivers, including sociodemographic characteristics, feeding behaviors, and self-reported health-related status of the children (i.e., diseases occurring after birth and in the past 2 weeks). The item on premastication asked, "have you or other caregivers ever prechewed food for your children?"

Anthropometric measurements of height, weight, and head circumference (HC) were collected during the fieldwork. The Infant/Child

ShorrBoard was used to measure child stature and recumbent infant length (if the child was <85 cm). Weight was measured using a portable scale with the child's clothing, shoes, and diapers removed. HC was measured by tape. World Health Organization Anthro software was used to calculate the growth and development status of the children, including weight-for-age Z-score (WAZ), height-for-age Z-score (HAZ), weight-for-height Z-score (WHZ), and HC Z-score. Underweight, stunting, and wasting were defined as WAZ < −2, HAZ < −2, and WHZ < −2, respectively. The HC Z score < −2 was defined as small head circumference.

Blood samples were obtained from finger pricks of 1,336 subjects. Hemoglobin (Hb) levels were measured during fieldwork using CompoLab TS (CompoLab TS, DiaSpect Medical GmnH, Germany) or according to recent medical records (results within 3 months).The main reasons for blood tests being refused for seven subjects were fear of the prick or excessive crying.

2.3 | Ethics

This study was conducted in compliance with the Declaration of Helsinki. All of the procedures involving human subjects were approved by the Medical Ethics Research Board of Peking University (No. IRB00001052–11042). Written informed consent was obtained from the primary caregiver of each infant and toddler.

2.4 | Statistical analyses

IBM SPSS predictive analytics software version 20.0 (IBM, 2016) was used to carry out the analyses. Descriptive statistics were completed for all of the variables, and they were presented as mean, median, or frequencies. Chi-square test, independent-samples *t* test, and nonparametric test were used in single factor analysis to compare the differences in the sociodemographic characteristics, nutritional indicators, and feeding cognition and behaviors between children with and without premastication. Linear regression was used to explore the associations between nutritional indicators and premastication by adjusting maternal education level, geographic location, and monthly expenditure on children. Binary regression was used to explore the associations between illness occurrences and premastication by adjusting age, maternal education level, geographic location, and monthly expenditure. The level of statistical significance in this study was set to $P < .05$.

3 | RESULTS

3.1 | Sociodemographic characteristics and premastication

Data from 1,341 children aged 6–36 months recruited for this study were included in the analysis. All of the children were the only child in each family. The majority of the subjects (94.9%) were of Han ethnicity. The mean age was 19.4 ± 9.0 months, 31.3% of children were aged from 6 to 12.0 months, 35.1% from 12.1 to 24 months, and 33.6% from 24.1 to 3 months. The total rate of premastication in participants was 26.9% and showed a significant geographic variation. Children living in the eastern part of China had the highest rates of premastication, whereas Chengdu and the capital city Beijing had lower rates. Children aged 6–24 months and with a low maternal education had higher premastication rates (see Table 1). There were no differences in family income, gender, birth weight, maternal height, and body mass index between children with and without premastication. Monthly expenditure on children, however, was positively associated with premastication (see Table 1).

3.2 | Nutritional indicators and premastication

The prevalence of anemia, stunting, wasting, and underweight in subjects was 3.5%, 6.2%, 1.3%, and 1.0%, respectively. There were no differences in hemoglobin, HAZ, WAZ, WHZ, and HCZ between children with and without premastication (see Table 2). In linear regression, after adjustment was made for maternal education, monthly expenditure and geographic location on children, premastication was still not associated with HAZ, WAZ, WHZ, or HCZ (see Table 3).

Both the illness occurrences after birth and in recent 2 weeks showed no significant differences between children with and without premastication (see Table 4). No association between premastication and illness occurrence was observed after adjusting for age, maternal education, geographic location, and monthly expenditure on children (see Table 5).

3.3 | Parental concerns, children's feeding behaviors, and premastication

In this study, 60.2% of children were raised by their parents and 37.3% were raised by their grandparents. Children who were raised by their parents had a higher rate of premastication (see Table 6). Parents who were concerned about the health status of their children and who thought that their children had obesity problem were more likely to give them prechewed food (see Table 6). Premastication was not associated with the participants' food picky behaviors.

4 | DISCUSSION

4.1 | Premastication prevalence

Complementary feeding is a crucial period for infants (Qasem, Fenton, & Friel, 2015). However, a great many children in developing countries have been found to have inappropriate feeding behaviors that affect their nutritional status (Issaka et al., 2015; Semahegn, Tesfaye, & Bogale, 2014). Premastication for infants by their caregivers is a common feeding practice in many societies, with reported rates of 14%, 60.9%, and 20.4% in America, South Africa, and Central Africa, respectively (Auer-Hackenberg et al., 2014; Centers for Disease Control, 2011; Maritz, Kidd, & Cotton, 2011). In this survey, we found that the premastication rate in Chinese infants and toddlers was 26.9%. In a qualitative survey of Chinese university students, Pelto et al. (2010) reported that 65 out of 104 (63%) of the students self-reported that

TABLE 1 Univariable analysis of sociodemographic characteristics of infants and toddlers with or without premastication, N(%) or mean ± *SD*

Variables		Premastication		*P*
		No	Yes	
Age	6–12.0 m	290(69.0)	130(31.0)	<.001
	12.1–24 m	320(68.1)	150(31.9)	
	24.1–36 m	369(82.0)	81(18.0)	
Gender	Boys	553(72.2)	205(27.8)	.433
	Girls	447(74.1)	156(25.9)	
City	Beijing	145(81.0)	9.4(19.0)	<.001
	Suzhou	112(64.0)	63(36.0)	
	Guangzhou	127(75.1)	42(24.9)	
	Zhengzhou	121(77.1)	36(22.9)	
	Chengdu	153(86.4)	24(13.6)	
	Lanzhou	106(63.9)	60(36.1)	
	Shenyang	122(79.2)	32(20.8)	
	Shanghai	94(57.3)	70(42.7)	
Mode of delivery	Vaginal delivery	449(71.8)	176(28.2)	.262
	Caesarean section	522(74.6)	178(25.4)	
Birth weight[a]	(kg)	3.38 ± 0.53	3.40 ± 0.63	.517
Maternal education	Senior high school or under	388(66.6)	195(33.4)	<.001
	Bachelor	488(77.1)	145(22.9)	
	Postgraduate or above	104(83.2)	21(16.8)	
Family capita				
Monthly income	<3,000rmb	461(72.1)	178(27.9)	.459
	3,000–6,000rmb	290(75.3)	95(24.7)	
	>6,000rmb	223(71.7)	88(28.3)	
Monthly expenditure on children	<500rmb	164(81.6)	317(18.4)	<.001
	500–1,000rmb	579(74.7)	196(25.3)	
	>1,000rmb	237(64.9)	128(35.1)	
Maternal height[a]	(cm)	160.9 ± 8.8	161.3 ± 4.9	.446
Maternal BMI[a]		21.0 ± 3.2	21.0 ± 3.8	.856

Note. SD = standard deviation.

[a]The birth weight, maternal height, and maternal BMI were continuous variables, and they were analyzed with independent *t* test; the other variables were analyzed with chi-square analysis.

TABLE 2 Univariable comparison of health indicators of HAZ, WAZ, WHZ, and HCZ score between children with and without premastication

Nutritional indicators	Premastication		*P*
	No	Yes	
Hemoglobin(g/L)[a]	N = 980	N = 361	
	126(119,132)	125(118,132)	.217
	N = 975	N = 359	
HAZ	0.23 ± 1.59	0.35 ± 1.47	.226
WAZ[a]	0.57(0.00,1.34)	0.69(0.00,1.38)	.281
WHZ[a]	0.73(0.00,1.47)	0.72(0.00,1.43)	.826
HCZ score	0.19 ± 1.42	0.18 ± 1.43	.881

Note. HAZ = height-for-age Z; HCZ = head circumference Z; WAZ = weight-for-age Z; WHZ = weight-for-height Z.

[a]Kolmogorov-Smirnov was used to test normality prior to analysis, and non-normal distribution were found for hemoglobin, WAZ, and WHZ. Hemoglobin, WAZ, and WHZ were described as median (25th, 75th) and analyzed with a nonparametric test. Other variables were presented as mean ± *SD* and analyzed with an independent *t* test.

they had received prechewed food in their childhood. This nonpopulation-based estimate cannot be compared to our population-based estimates of premastication practiced many decades later. Nonetheless, it is also noteworthy that in some cities of China, such as Shanghai, premastication is still common and occurs in nearly half of all children.

Infants as young as 10 days old are reported to be receiving prechewed foods (Aggett, 2010). More commonly, the age of introduction seems to be nearer 3–4 months, but none of these results are really systematic data (Aggett, 2010). In this study, we found that premastication was more frequently reported in the 6–24 months group. However, a decline of prevalence of ever-premastication as children get older should be impossible for this prevalence, which is cumulative with age. This would be possible due to forgetting or to a misunderstanding by the caretakers of the question "have you or other caregivers ever prechewed food for your children?" to mean "have you or other caregivers recently prechewed food for your children?"

TABLE 3 Linear regression for premasitication of hemoglobin, HAZ, WAZ, WHZ, and HCZ among Chinese children (N = 1341)

Predictors	Unstandardized coefficient	95% (CI)	*t*	*P*
Hemoglobin				
Model 1[a]	−0.995	(−2.856,0.866)	−1.048	.295
Model 2[b]	−0.539	(−2.389,1.311)	−0.571	.569
HAZ				
Model 1[a]	0.117	(−0.072,0.306)	1.212	.226
Model 2[b]	0.150	(−0.040,0.340)	1.545	.123
WAZ				
Model 1[a]	0.039	(−0.096,0.175)	0.566	.572
Model 2[b]	0.039	(−0.098,0.176)	0.557	.577
WHZ				
Model 1[a]	−0.029	(−0.167,0.108)	−0.420	.675
Model 2[b]	−0.051	(−0.190,0.089)	−0.713	.476
HCZ				
Model 1[a]	−0.013	(−0.186,0.159)	−0.149	.881
Model 2[b]	−0.067	(−2.389,1.311)	−0.571	.569

Note. CI = confidence interval; HAZ = height-for-age Z; HCZ = head circumference Z; WAZ = weight-for-age Z; WHZ = weight-for-height Z.

[a]Model 1 used to obtain the crude odds ratio.

[b]Model 2 used to adjust for maternal education level, geographic location, and monthly expenditure on children.

TABLE 4 Univariable comparison of illness occurrences between urban Chinese children with and without premastication, N(%)

		Premastication		
Variables		No	Yes	*P*
Illness after birth	<3 times	572(71.7)	226(28.3)	.161
	≥3 times	408(75.1)	135(24.9)	
Illness in recent 2 weeks	None	555(74.8)	187(25.2)	.114
	Yes	425(71.0)	174(48.2)	

TABLE 5 Binary logistic regression for illness occurrences of premastication in Chinese urban children (N = 1,341)

Variables[a]	B	Wald	OR	95% (CI)	*P*
Illness occurrences after birth	−0.057	0.182	0.944	(0.727,1.228)	.669
Illness occurrences in recent 2 weeks	−0.218	1.839	0.804	(0.587,1.102)	.175

Note. CI = confidence interval; OR = odds ratio.

[a]Adjusted with age, maternal education, geographic location, and monthly expenditure on children.

TABLE 6 Comparison of parental feeding cognition and feeding behaviors between children with and without premastication, N(%)

		Premastication		
		No	Yes	*P*
The primary caregivers	Parents	565(70.0)	242(30.0)	.005
	Grandparents	386(77.2)	114(22.8)	
	Nurse or others	29(85.3)	5(14.7)	
Health concern of children	No	633(75.2)	209(24.8)	.022
	Yes	345(69.4)	152(30.6)	
Perception of child's weight				
	Obesity	53(59.6)	36(40.4)	.001
	Thin	155(68.3)	72(31.7)	
	Standard	766(75.4)	250(24.6)	
Picky eater	No	745(76.0)	274(26.9)	.972
	Yes	235(73.2)	86(26.8)	

4.2 | Premastication and health

There seems to be an agreement that premastication may have a number of nutritional benefits, as well as benefits from the digestive enzymes present in saliva (Aggett, 2010). All of this, however, remains hypothetical because only a handful of observational studies have reported that premastication might contribute to reduction in anemia and stunting (Fry, 1957; Pijoan & Elkia, 1943). There are many knowledge gaps that need to be explored and prioritized (Aggett, 2010). In this study, there were no associations observed between premastication and nutritional indicators. These results might be attributable to the fact that all of the children were recruited from eight modern cities in China with high economic status in which malnutrition is rare. Future studies should be encouraged to focus on areas with a poor nutritional status.

On the other hand, the risk of transmitting pathogens is a common concern about premastication among commentators (Aggett, 2010; Pelto et al., 2010). Meanwhile, abundant antimicrobial factors and microflora exist in saliva, which might give long-term immune-competence and immune-tolerance benefits for infants (Pelto et al., 2010). In this study, all of the caregivers were generally healthy without AIDS or HIV infection, hepatitis B, and other diagnosed infectious diseases. Hence, it is not possible to ascertain whether premastication carries

increased microbiological risk. Additionally, because researchers have expressed concern that premasticated foods might displace breastfeeding, more research on the effects of the food on the functional properties of breast milk is required (Aggett, 2010).

Although no significant associations between premastication and health were shown in this study, there are still a lot of knowledge gaps in our understanding of premastication. Given that premastication is a common feeding behavior in China and is reported in many societies, and also because it is controversial, there is an urgent need for future studies of the health effects of premastication. These studies will be able to give support to the policy and feeding recommendations about discouraging or supporting and complementing premastication. They may also help to improve the well-being of children and their families in different environmental and social contexts. Additionally, other health effects of premastication, such as the effects on the children's masticatory ability and even the nonbiological factors, such as economic, mother–infant interaction, and cultural benefits, should be taken account in further research to understand the comprehensive roles of premastication.

4.3 | Premastication and parental concerns

An interesting finding in the present study was that parental concern about infant health, not the actual health status, was related to premastication. Parents who reported higher expenditure on infants, who were concerned about the health status of their children, and who thought that their children had an obesity problem, were associated with a higher prevalence of premastication. These parents might share similar characteristics of paying more attention or giving more care to their children. In addition, a feeding habit of chewing carefully and swallowing slowly is thought to be a strategy of weight control for children, which might explain the higher premastication rate in parents who thought their children were obese. From this, we inferred that premastication in contemporary China is more related to parental choice than to the infant's actual nutritional needs.

In this study, premastication was more frequently found in infants who were raised by their parents. This finding is different from the public perception—in China, grandparents were perceived to prefer to prechew food for their grandchild. This finding indicated that premastication is also common in the new-generation parents.

We also found that a lower maternal education level was associated with a higher prevalence of premastication. Although whether premastication is a wise or inappropriate feeding behavior still needs further discussion, the poor maternal education experience usually contributes to a poor feeding practice (Saleem, Mahmud, Naila, & Zaidi, 2014). Similarly, the economic status is often related to a series of different feeding behaviors. However, there is no difference of family incomes between children with and without premastication in this study. One of the explanations could be that this study was conducted in urban areas, where the economic status is generally good. Further cross-cultural studies are required to explore the demographic characteristics of premastication.

4.4 | Limitations

This study was a cross-sectional study, and, therefore, the causality between exposure factors, nutritional indicators, and premastication could not be observed. Additionally, the caregivers may have had a recall bias during the interviews, which may have affected the reliability of their reports, especially in the caregivers of toddlers.

The data that we used in this study comes from the MING study, which is not only designed for premastication. Therefore, unfortunately, many meaningful indicators of premastication were not investigated, such as the frequencies of mastication, types of prechewed food, and the reasons for practicing premastication. More studies are needed to clarify the roles of premastication on the infants' nutritional status and health.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

YZ designed this study; AZ drafted the paper; YX, WZ analyzed the data; HL, ST, WZ collected the data; PW revised this paper.

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